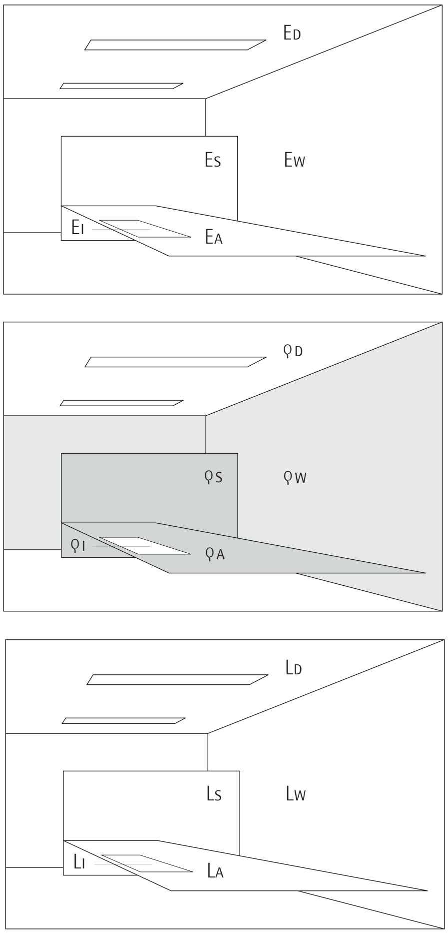
colours appear particularly intense – similar to projected slides or lighting using framing projectors.

At first glance this appears to be a promising concept, which avoids the weak points of quantitative lighting design and provides criteria for a perception-oriented design theory. Considerable doubts have arisen from the perceptual psychology sector, however, as to whether luminance and luminance distribution are suitable criteria for a lighting design theory based on human perception.

Luminance is indeed superior to illuminance in as far as it forms the basis for perception – light itself is invisible. It can only be perceived when it is reflected by objects and surfaces. Luminance, however, is not identical to the brightness we actually perceive; the luminance pattern on the retina only provides the basis for our perception, which is completed through complex processes in the brain. This also applies to luminance scales that are adjusted to the state of adaptation of the eye or the conversion into equidistant grades of brightness – there is no direct correlation between the image actually perceived and the luminance pattern on the retina.

If luminance were the only factor that determined our perception, we would be helplessly exposed to an array of confusing patterns of brightness produced by the world around us. We would never be in a position to distinguish the colour and reflectance of an object from different lighting levels, or perceive three-dimensional forms. It is nevertheless exactly these factors of constancy, the forms and material qualities around us, that our perception is aimed at; changing luminance patterns only serve as an aid and a starting point, not as the ultimate objective of vision.



Simplified correlation between illuminance E, reflectance ρ and luminance L in working places with visual task I, working surface A, ceiling D, wall W and partition walls S.

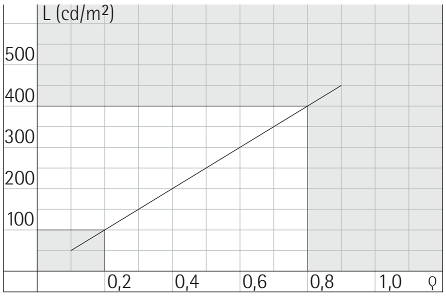
E_I = 500 lx
E_A = 500 lx
E_D = 50 lx
E_W= 200 lx
E_S = 200 lx

ρ_I = 0,7
ρ_A = 0.3
ρ_D = 0.7
ρ_W= 0.5
ρ_S = 0.3

L_I = 111 cd/m^2
L_A = 48 cd/m^2
L_D = 11 cd/m^2
L_W= 32 cd/m^2
L_S = 19 cd/m^2

Calculation of luminance L from the illuminance E and the reflectance ρ. The formula only applies in the case of completely diffuse reflection, but generally produces good approximate values in practice.

$$L = \frac{E \cdot \rho}{\pi}$$



Preferred luminance L for visual tasks as a function of reflectance ϱ of the visual task. The luminances preferred in the experiment are in proportion to the reflectance factor; they result when the illuminance level remains constant. Consequently, in the case of the perception of visual tasks, in comparison to luminance, illuminance is a prime criterion.

Only with knowledge of the lighting conditions and with the aid of constancy phenomena can interpretations be made of the luminance pattern on the retina, and a familiar three-dimensional image arise from the mass of confusing parts. The brightness ratios that we actually perceive may deviate considerably from the underlying luminance pattern. In spite of its higher luminance a grey, overcast sky seen above a field of snow will appear to be darker than the snow. The decline in luminance over a wall surface lit from an angle is likewise ignored, whereas it has an increased effect on the sides of a cube. Colour ratios and grey values are thus corrected in differently lit areas, with the result that we perceive a consistent scale.

In every case, the registering of luminances is deferred in favour of the constant qualities of objects, which is inherent to our perception: the acquisiton of information about a given environment clearly has higher priority than mere optical images. This central aspect of the way we process information cannot be taken into consideraion by a theory of perception based on luminance, however. Similar to quantitative lighting design, luminance technology adheres to a purely physiological concept, which reduces the perceptual process to the creation of optical images in the eye, ignoring all other processes that take place beyond the retina. The information content of our perceived environment and the interest this environment awakens in the perceiving being cannot be explained by this model - but it is this very interplay of information and interests that allows the perceived image to be processed, the relativity of luminances to be apprehended and the luminance patterns in the eye to be reinforced or ignored.

If the aim of perception is to process information, and if it takes place depending on the information provided, it cannot under any circumstances be examined irrespective of the information content provided by or inherent in a specific environment. In the light of this fact, any attempt to define a set of general rules for lighting that are not based on a concrete situation is of doubtful validity. This also applies to the attempt to make an abstract definition of "stable" lighting situations, which is what luminance-based design strives to do.

A general definition of the conditions required for the development of psychological glare - the most extreme form of an "unstable", disturbing lighting situation - will fail due to the fact that the information content pertaining to the relevant glare sources is not available. It becomes apparent that glare does not only depend on stark luminance contrasts, but also on lack of information content with regard to the surface producing the glare. It is not the window with a view over the sunlit countryside that gives rise to glare, but – in spite of its lower luminance factor – the pane of opal glass that prevents this very view; a blue summer sky with a few clouds is not a source of glare, but the uniform grey-white sky of a dull day in November.

If it is not possible the find an abstract definition for an "unstable" milieu, the attempt to describe ideal luminance patterns out of context is unsound. Maximum luminance contrast values of 1:3 or 1:10 between the object of attention and the proximate or broader ambient field have been laid down that confine the lighting designer's range of expression to a dull average. Phenomena such as brilliance and accentuated modelling, which play a considerable role in imparting information about materials in our environment, are practically excluded; luminance situations such as we experience on any sunny day or on a walk in the snow, are considered to be unreasonable. But you can only decide whether a lighting situation is pleasing or unreasonable when you experience a specific situation; luminance contrasts on the beach are not too stark for someone taking a stroll, but they will bother someone who is trying to read a book.

Just as the brightness we actually perceive cannot be derived from luminance, it is impossible to conclude the exact lighting conditions which are necessary to ensure good perception simply by examining the contrast range of a lit environment; the lighting designer is obliged to examine each specific situation, the information it provides and the perceptual requirements of the users of the space.

The difficult aspect to evaluating the quality of lighting concepts is the exceptionally vast adaptability of the human eye: a perceptual apparatus that is able to provide usable results at 0.1 lux on a clear night or 100 000 lux on a sunny day, is not substantially disturbed in its performance by luminance contrasts of 1:100, and is entirely capable of balancing the effects of inadequate lighting design. It is therefore not surprising that lighting installations that do not take into account the essential requirements of the perceiving person generally meet with acceptance. Dissatisfaction with the lighting at a workplace, for example, is frequently not recognised by the person concerned as a result of poor lighting design – criticism is usually aimed in the direction of the innocent "neon lamp".

Progress made in the field of lighting design can therefore not be evaluated by simply differentiating between inadequate and optimum, or clearly correct or incorrect lighting solutions. In the case of the lighting of workplaces a quantitative design concept may prove to be clearly successful, even when the lighting is exclusively adjusted to optimising visual